occurs at the bottom of the greater part of the Irish Sea. All along the coast of Lancashire, Cheshire, and to a certain extent North Wales, the peat, with a forest at its base and the clay containing the roots of the trees, may be seen, nowhere so well as at Leasowe, in Cheshire, and at the mouth of the Alt, Hightown, Lancashire (eight or nine miles from Liverpool). In both localities the peat, the forest at the base, and the grey clay below, occupy the country inland, run *under* the sand dunes, emerge on the coast, and disappear under the sea sand at low-water mark. In North Cheshire the peat is sometimes split into two, a bed of grey clay, with *Scrobicularia piperata*, being intercalated in the mass. This I consider to have been formed when the Mersey entered the sea, through what is now the gorge of Wallesey Pool. Very near the top of the peat a thin seam of sand occurs, both in Cheshire and Lancashire, containing *Tellina Balthica* and *Cardium edule*. I called it the zone of *T. Balthica*. The grey clay of the Isle of Man, with *Cervus Megaceros*, is no doubt of the same age as the "Cyclus Clay" of Lancashire.

Those who visit Hightown will find the peat, which is there from twelve to twenty feet thick, covered on either side of the River Alt with an alluvium which, near the sea, contains *Scrobicularicæ*, and inland graduates into a fluviatile deposit, with freshwater shells. They will find the base of the sand dunes, where they rest on the upper surface of the peat, to be, as at Leasowe, in North Cheshire, a freshwater deposit, which I called the *Bythinia tentaculata* sand; it contains thin seams of peat up to a height of eight or ten feet from the base.

My notes are already so long that I abstain from saying anything of the marine fauna of the coast and other matters: those that I have written refer to districts in which the maps, &c., of the Geological Survey are already published, and I have of course written as a private geologist, stating my individual opinions.

C. E. DE RANCE

H.M. Geological Survey

THE SECOND PROVINCIAL MEETING OF THE IRON AND STEEL INSTITUTE

THE Institute bearing the above name was originated about two years ago, chiefly by the North of England ironmasters, among whom there are many gentlemen who combine in themselves great practical skill and a large amount of scientific knowledge. It was not formally launched into existence till the month of June, 1869, when the inaugural address was delivered to a meeting of the members, held in the Hall of the Society of Arts, by the president, the Duke of Devonshire, who is intimately and extensively connected with the iron and steel trades through the great works of Barrow-in-Furness, perhaps the greatest Bessemer steel works in the world. The aim of the Institute is to hold two meetings annually—one in London, in the spring, and the other in the country in the autumn. The first provincial meeting was held, about a year ago, in Middlesborough, the capital of the Cleveland district, the greatest and most scientific iron-making district either in this or any other country. In May last the second metropolitan meeting was held; and now the second provincial meeting has just been held at Merthyr Tydvil, in South Wales. At all these three meetings there have been read papers of very great interest and importance, both from a scientific and a practical point of view. Then, taking the experience of the two provincial meetings, the members not only have the benefit of hearing the papers read and of taking part in the discussions to which they give rise, but they also have the opportunity of visiting the numerous works that are thrown open for their inspection, where they can see scientific theories put to practical tests, and where they can compare notes with each other upon the subjects which deeply concern them as practical and professional men. It is well known that "iron sharpeneth iron:" and in these country meetings of the Iron and Steel Institute this wise saw has many apt illustrations. Examples to imitate are seen in abundance; many points are observed that are suggestive and that excite to further improvements in other hands; and in numerous instances things are seen which impart lessons of a totally different sort, inasmuch as they show what errors of commission are to be avoided. Both successes and failures can give instruction to thoughtful minds.

This year's provincial meeting of the Institute, as already indicated, has been held at Merthyr. It opened on the morning of Tuesday, 6th September, in the Temperance Hall of that town, the centre and most important seat of the iron trade of South Wales. After the transaction of some formal business, and the appointment of Mr. Henry Bessemer as the president-elect of the Institute, the business of reading and discussing the papers prepared for the meeting was proceeded with. Altogether there were seven papers set down for reading and discussion on the mornings of Tuesday and Wednesday, the 6th and 7th September, which was all the time that could be devoted to that work, as the afternoons were required for visiting and inspecting the works in and immediately around Merthyr, while Thursday and Friday were required for the inspection of works at a distance. One praiseworthy feature in connection with the meetings in Merthyr was the circumstance of printed copies of the papers being in the hands of the members before they were read by the authors. Owing to this arrangement members were generally enabled to come prepared to enter upon the discussion of the papers with intelligence and with some degree of satisfaction. In two instances the papers supplied to the members were accompanied by engravings of the objects described. Both of these features of the Iron and Steel Institute Meeting might be copied with advantage by other learned societies, as they are calculated to impart additional interest to the meetings.

The Iron and Steel Institute already numbers upwards of 350 members, including several peers of the realm, about a dozen members of Parliament, and almost every person in the kingdom who has of late years added to the stock of our knowledge regarding the manufacture, the manipulation, and the use of iron and steel. It has very soon acquired a national importance, and its future prosperity seems to be almost assured. In order to make the Institute more and more useful to the persons who may be connected with it as members, it is intended to publish a Quarterly Journal of the Institute instead of the Transactions. This will commence on the 1st of January, 1871, and its contents will be as follow:—

First, the proceedings of the Institute, and of the Council from time to time. Second, the papers and discussions at the general meetings of the Institute. Third, communications from members upon matters of special interest to the trade, which are approved by the Council. Fourth, a quarterly epitome of inventions, discoveries, publications, and proceedings bearing upon the British iron and steel trades. Fifth, a comprehensive report on matters connected with the iron and steel trades in foreign countries. It is very satisfactory to know that the foreign department of the journal will be under the special management of Mr. David Forbes, F.R.S., and that the general editorship will be conducted by Mr. John Jones, F.G.S., the Secretary to the Institute and to the North of England Iron Trade.

We now proceed to give a brief notice of the papers read at the recent meeting at Merthyr:—

I. "On the Geological Features of the South Wales Coal-Field." By Mr. William Adams, Cardiff. In this paper, which was of special interest to such of the members as were strangers to the district, the author traced the history of our knowledge regarding the position, nature, and extent of the coal deposits which have given such an industrial importance to South Wales. Attention was directed to this coal-field as far back as the year 1570, but the essay itself did not appear till the year 1796, when it was published in the *Cambrian Register.* Since that time many persons have devoted attention to the subject, including Edward Llwyd (1697, "Philosophical Transactions," 1712); Edward Martin (Royal Society, 22nd May, 1806); Buckland and Conybeare (1822, "Geological Transactions," vol. i.); Robert Bakewell (1833); Sir Henry J. De la Bêche (1846, "Memoirs of the Geological Survey," vol. i.); Mr. Hussey Vivian, M.P. (1860); and Mr. Hull (1861, "Coal Fields of Great Britain"). According to Mr. Adams, the South Wales coal-field extends from Blaenavon and Pont-y-pool, on the east, to St. Bride's Bay, in Pembrokeshire, on the west, a distance of about ninety miles; while its breadth varies from about sixteen miles on the east to about four miles in the extreme west. The superficial area is given as low as 906 square miles (Hull), and as high as 1,200 square miles; but Mr. Adams puts it at 937½ square miles, or 600,000 acres. Taking the average thickness at sixty feet, as given by Mr. Vivian, M.P., one of the Royal Commissioners on the Coal Supply, and deducting one-third for loss in working, for faults, waste, &c., the extent of coal is 36,000,000,000 tons. The author pointed out the qualities of the mineral in different parts of the coal-field. On the east it is bituminous, and makes a very superior coke; it continues so to Rhymney; at Dowlais it becomes free-burning; at Cyfarthfa it begins to take on the characters of anthracite; and further westward the coal becomes more and more distinctly anthracitic, until, in the west, it becomes so pure that it is worked for drying hops and malt and for distilling purposes, &c. Within the field there are obtained the well-known steam coals of Merthyr, and the Aberdare and Rhondda valleys. Argillaceous ironstones are very abundant and good. They are interstratified with the coal, and have an aggregate thickness of from sixty to seventy inches or upwards, and until about thirty years ago they yielded practically all the iron which was smelted in Wales. Since then the deficiency for the ironworks has been drawn from other British and foreign mines. The pig iron made in South Wales in 1854, according to Mr. Hunt's "Mineral Statistics," was 750,000 tons, and the coal raised in the same year was 8,500,000 tons, while the amount raised in 1868 was 13,210,000 tons. Owing to the remarkable denudation in the valleys of the district, the lowest seams of coal can be won by pits of less than 1,000 yards in depth throughout about two-thirds of the basin. A greater depth may be required west of the Vale of Neath and on to Llanelly, where the deepest part of the basin occurs. Throughout the coal-field there are faults, running north-west and south-east, which give a vertical displacement of 250 or 300 yards; and there are others running east and west which give a displacement of from 400 to 500 yards; and one is said to occur in Pembrokeshire which is equal to a displacement of upwards of 666 yards. The deepest pits are those which reach down to the nine-feet seam; their depth varies from 304 to 435 yards. In the coal-field there is found some of the best fire-clay known; there is also a remarkable siliceous stone, which is used to make the well-known refractory fire-bricks called Dinas brick. Alum shales occur, and, near Pont-y-pool, a rich oil shale is found, which yields on distillation from fifty to fifty-five gallons of crude oil, of which twelve to fifteen per cent. may be separated as mineral turpentine. Mr. Adams also referred to the extent and distribution of the mountain limestone—so useful as a flux in smelting the ironstone—and in the fossils which the coal measures of the district contain; and, in concluding his very valuable paper, he also strongly urged the desirability of a new geological survey on the six-inch scale being made.

In the course of a short discussion which followed the reading of the paper, several interesting points were raised, more especially in reference to the effects of the faults in changing the character of the coal.

II. "On Pumping and Winding Machinery." By Mr. G. C. Pearce, Cyfarthfa Iron Works. This paper embraced a short description of the pumping and winding machinery lately erected at the Castle Pit, near Merthyr, the property of Mr. R. T. Crawshay. Notwithstanding the shortness of the paper, it would be difficult to give a satisfactory description of the machinery in the form of an abstract, especially without illustrations. But a few facts may be mentioned. The pit is 333 yards in depth to the bottom of the sump, but the pumps only raise the water 279 yards, where there is an adit. It is of an oval form, 22 feet 8 inches long by 12 feet wide, with a brattice dividing the winding parts from the pumps; and it is all built with brick throughout. The total cost of the machinery and the sinking of the pit was about 30,000*l.*, the winding engine alone costing above 4,000*l.*

In the afternoon of Tuesday the Castle Pit was visited by the members of the Institute, many of whom were much struck with the gigantic and ingenious character of the machinery erected by Mr. Pearce.

Mr. E. A. Cowper, C.E., F.R.S., followed with some observations in reference to the working of steam for pumping, winding, and blowing engines; but no discussion ensued.

III. "On the Condition of Carbon and Silicon in Iron and Steel." By Mr. George J. Snelus, Associate of the Royal School of Mines, chemist at Dowlais Iron Works. This paper was of considerable length and very elaborate. It contained the results of a long course of experimental inquiry, instituted with a view to determine the conditions in which the two non-metallic bodies, carbon and silicon, exist in iron and steel. Dr. Percy had said in his celebrated work, "Iron and Steel," that not a trace of graphite could be detached by the point of a penknife from the fractured surface of highly graphitic iron; but Mr. Snelus had proved the incorrectness of this statement by examining some pig iron which had cooled slowly under a mass of slag, and which had in consequence very large crystals. From the surfaces of these crystals the graphite could not only be separated with the point of a penknife, but even with the finger-nail; and when the graphite was removed the iron underneath rapidly rusted in a damp atmosphere. The same thing was afterwards observed with the fractured surface of Bessemer pig-iron, and the scales removed were found on further examination to be pure carbon. By pulverising pig-iron and then using the magnet a considerable amount of graphite was separated. Other mechanical means were employed, and the same results were obtained. In spiegeleisen the carbon was found to be almost wholly combined. The author had never found as much as five per cent. of combined carbon in pig iron, although many analyses had been published in which the carbon was put down at even six per cent. Mr. Snelus was not inclined to believe that there was any definite compound of carbon and iron but, he thought that the carbon was dissolved in the iron, the amount taken up by the molten iron varying according to several circumstances. According to Mr. Snelus there is no pig iron that is destitute of silicon, and he had never met with a case in which either steel or wrought iron was totally free from it. Good Bessemer and tool steel rarely contains more than two or three parts in 10,000. One part of silicon in 1,000 of Bessemer steel renders it hard and brittle when cold. In ordinary Bessemer pig iron it is present in quantities varying from one to four per cent. The author gave it as his opinion, from experimental inquiries, that silicon is dissolved or "occluded" in iron in the same way as carbon is, but that the solvent power of the metal is so much greater for silicon than for carbon, that it is quite a rare thing, even if it ever occurs, for silicon to separate in a free state from the iron; and he considered that the methods of mechanical separation which he had adopted for the investigation of the condition of carbon and silicon would prove effectual aids to the ultimate analysis of iron, and a valuable supplement to the ordinary methods of research.

Mr. Isaac Lowthian Bell complimented Mr. Snelus upon the great value of his paper, and criticised some of the statements made in it. On the presence of silicon in steel, Mr. Bessemer said that a very general opinion prevailed in the trade (and it was correct when they spoke of large quantities) that silicon was deleterious to the make of iron. It was the impression that they should get rid of silicon, and they would then make better iron. That was not the case, in proof of which assertion he called attention to the old steel process as carried on in Sheffield, and adduced instances to show that the presence of silicon improved the quality of the manufacture. He had not had an analysis of the best quality of Sheffield steel that did not contain silicon.

A discussion was then taken upon a paper read at the meeting held in London in May last, the subject of which was "A Method of Designing Rails," and the afternoon was spent in visiting the works of the Plymouth Iron Company, the Castle Pit winding and pumping machinery, and the Cyfarthfa Iron Works, the property of Mr. Crawshay. At the last-named works there was seen an immense stock of puddled iron, upwards of 20,000 tons, stacked in "houses," each containing 300 tons.

The proceedings were resumed on Wednesday morning. The papers read were the following:—

I. "On a New Form of Pyrometer." By Mr. C. W. Siemens, C.E. F.R.S. D.C.L. After describing briefly the Wedgewood and Gauntlett pyrometers, and one previously constructed by himself, Mr. Siemens proceeded to describe a pyrometer of more universal applicability. It is based upon the peculiar properties of the pure metals to offer an increasing resistance to the passage of an electrical current with increase of temperature. A platinum wire of known electrical resistance is wound upon a cylinder of fire-clay, upon which a helical path has previously been cut to prevent contact between the turns of the wire. The coil of wires, so prepared, is enclosed within a cylindrical casing of platinum if the temperatures to be measured exceed the welding heat; or of iron or copper, if lower temperatures only require to be measured. The two ends of the coil of wire are brought out end ways, and are attached within the protecting tube to thicker leading wires of copper, insulated for a short distance by being passed through pipe-clay tubes, and further on by india rubber or gutta percha, terminating at the measuring instrument, which may be placed at any convenient distance. The characteristic feature of this instrument is that the usual calculations necessary to determine electrical resistances by the Wheatstone or other methods are dispensed with, and a reading in degrees of a large scale is at once obtained by so placing the index lever that the electrical current, generated in a small battery and passed through the measuring instrument, including the platinum wire of the pyrometer, produces no deflection of the galvanometer needle. The temperature which these degrees represent is expressed by a table of reference, which accompanies each instrument. The correctness of this instrument depends solely on the ratio of increase of electrical resistance in the platinum wire, with increase of temperature. This rise is considerable, the resistance being increased fourfold by an increase of temperature from the freezing point to about 3,000° Fahr. The ratio of increase is, however, not uniform, but follows a parabolic law which the author embodied in a table. The pyrometer last described is the result of more careful investigation on the part of Mr. Siemens, who has been animated by a desire to fill up a blank in the means at our disposal to carry on metallurgical inquiries with a high degree of certainty, and he therefore does not seek any commercial compensation, through the Patent Office or otherwise, for using this invention.

A discussion followed, in which Mr. Snelus, Mr. I. L. Bell, and Mr. E. A. Cowper took part.

II. "On the Efficiency and Durability of Plain Cylindrical Boilers." By Mr. Jeremiah Head, Middlesborough. The author of this paper aimed at pointing out the many high qualities possessed by the plain cylindrical boiler, to investigate the cause and extent of the defects which they possess, and to point out satisfactory remedies for them. Such boilers are still in large request. Out of 17,825 boilers now on the books of the various boiler insurance companies 4,052, or 22·7 per cent., are of this type. But such boilers are very liable to fracture and break their backs, and Mr. Head gave an explanation of the causes of such occurrences, and explained the method which he had adopted to prevent the recurrence of such a mishap in a boiler that had been repaired about the beginning of March last. His plan is to suspend the boiler upon volute springs. No springs are necessary for boilers of 30 feet long upon two supports; but for lengths of 60 to 75 feet five supports are required, the end ones being furnished with double springs.

The discussion following this paper was so long that no time was left for the consideration of a paper by Mr. Kohn, C.E., on "The Production of Alloys of Iron and Manganese, and on their Application to the Manufacture of Steel." A paper on "A Contribution to the History of the Puddling Process" was also left over for consideration at the next meeting in London. On that occasion the place will be selected for the next autumn meeting.

In the afternoon of Wednesday, the world-famous works of the Dowlais Company were visited by the members of the Institute. Thursday was occupied with a visit to Swansea, where an inspection was made of the Landore Steel Works, where the Siemens-Martin process is carried on; the Hafod Copper Works, belonging to Mr. Vivian, M.P., and the Spelter Works. Friday was devoted to a visit to the Crumlin Viaduct and the Ebbw Vale Company's Iron and Steel Works. These several inspectorial visits were thoroughly enjoyed, and the hospitality with which they were attended was most profuse. Doubtless, many of the practical and professional men who were present at the inspection gained a large fund of mental insight which will, ere long, be applied to practical advantage, or, at all events, be put to a practical test.

JOHN MAYER

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his Correspondents. No notice is taken of anonymous communications.*]

A Mirage

As several notices of Mirage seen in Britain during the present year have recently appeared in NATURE, I venture to trouble you with the following substance of a few brief notes (made on the spot) of an instance which I witnessed on April 15, 1870.

With a companion I was walking slowly from Chesilton, in the "Isle" of Portland, along the western slope of the famous Chesil Bank, in a north-westerly direction—my friend on one of the numerous narrow terraces into which the slope is broken, I on that next below. The day was bright and warm, and the sea was calm. Having occasion to stoop down, I caught sight of what for the moment I thought a considerable pool of water on the terrace on I which stood, in the direction in which we were